

**METHOD AND APPARATUS FOR PARTITIONING SYSTEM MANAGEMENT
INFORMATION FOR A SERVER FARM AMONG A PLURALITY OF
LEASEHOLDS**

5

RELATED APPLICATION

The present invention is related to commonly assigned and co-pending U.S. Patent Application Serial ~~fn~~ 3/30/04
10 No. 09731613 (Attorney Docket No. AUS920000416US1)
entitled "METHOD AND APPARATUS FOR TIME DECAY MONITORING
OF APPLICATION, NETWORK AND SYSTEM BEHAVIOR," filed on
even date herewith, and which is hereby incorporated by
reference.

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BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention is in the general area of
20 computing systems and information technology and is
directed more specifically to the management of a large
number of such systems where the systems are divided
among a number of different customers. The present
invention is directed to a method and apparatus for
25 partitioning system management information for such a
server farm among a plurality of -customers.

2. Description of Related Art:

Thin servers or server appliances have been
30 developed to provide specialized servers that are
typically cheaper and easier to install and use than
traditional server computer systems. The terms *thin*

server and server appliance are essentially synonymous and are used interchangeably throughout the balance of this document. A thin server is a network-based computer specialized for some function such as print serving, ISDN
5 routing, web serving or network attached storage (NAS). Web server software is often built in allowing management and control via a Web browser residing on any client platform in the network although that is not a necessary feature.

10 Farms or clusters of thin servers are being used to provide web-based application services as a single system from an administrative and management perspective while maintaining multiple execution images. For a variety of reasons including bandwidth access, cost reduction and
15 flexibility, many web-based applications are being hosted on thin server farms, or clusters, which are owned and/or operated by other groups, and in turn, these groups may lease portions of the facility to a number of different customers. When a server farm is split among multiple
20 end customers, each of whom has contractually defined rights to service from the hardware and software in the farm, the farm is described as being partitioned into leases or leaseholds.

In known farms, all management function is performed
25 by the owner or operator of the farm on behalf of all of its customers. A standardized report is then generated and provided to each of the customers. The standardized report provides information that may not be easily used by the customers since the standardized report is not
30 specific to each customer. The report is also static and does not allow for direct and interactive management of the resources within the farm as a part of the customers'

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overall information technology infrastructures using the customers' previously established management tools and methodologies. Accordingly, it would be beneficial to have a method and apparatus for partitioning system
5 management information for a server farm among a plurality of leaseholds in such a manner as to facilitate the use of the individual customers' pre-existing system management tools.

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SUMMARY OF THE INVENTION

5 The present invention provides a method and
apparatus for partitioning system management information
among a plurality of leaseholds. With the method and
apparatus of the present invention, a thin server farm is
operated as a shared or leaseable facility. As such, the
10 customers using the shared facility execute their server
applications on the servers that they lease and provide
system management agents that run on a thin server
manager, which may be implemented as part of a management
server appliance for the thin server farm, for example.
15 The agents gather management information and perform
management functions on the portion of the shared
facility that they are currently using.

With the present invention, the thin server manager
aggregates all of the information about the applications,
20 the network and the systems in the network. The thin
server manager is also given a set of information, which
may be in the form of extended markup language (XML)
documents, that describes the leases that are in force
and the service-level agreements of contractually defined
25 obligations associated with each of the leases. The thin
server manager has, as part of its management information
base, the current assignments of resources to each
leaseholder, the status of each lease, and how the
resources are being used, e.g., what applications are
30 being run under the lease, on how many servers the
applications are being run, how much network bandwidth is
being used, the level of success of running the

applications, and the like. Based on this information, the thin server manager creates for each lease a computer-processable document in a form, such as XML, that it forwards to an adapter for each of the
5 leaseholder agents.

The adapters and the leaseholder agents may all run on a management server appliance or metaserver system or be on different systems. Each adapter acts as a translation layer, converting the document to a format
10 which the leaseholder's agent can handle. The document contains only the information about the leased resources rather than a full picture of the facility.

If the leaseholder's system management software issues a command to some entity within the leased portion
15 of the server farm, the command is translated by the adapter to a document parsable by the thin server manager. The thin server manager determines if the command is an appropriate command, makes any required translations or restrictions, and then forwards it to one
20 or more agents within the leasehold.

The present invention offers, among others, three major advantages in the operation of server farms, especially ones using thin servers or server appliances. First, the present invention provides a mechanism for a
25 single server appliance to manage multiple sets of appliances where each set is being used by a different customer of the server farm or for a different purpose. Second, the present invention allows each customer of the thin server farm to use the customer's own system
30 management infrastructure to manage its portion of the thin server farm as an extension of the information technology systems that the customer owns or already has.

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Third, the invention eliminates the cumbersome and often usable reports that are typically generated by a service provider or server farm operator for its customers. Other features and advantages of the present invention will be described in, or will become apparent to those of ordinary skill in the art in view of, the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

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The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best
10 be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an exemplary diagram illustrating a distributed data processing system according to the
15 present invention;

Figure 2 is an exemplary block diagram illustrating one embodiment of the thin server manager according to the present invention; and

Figure 3 is a flowchart outlining an exemplary
20 operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 is an exemplary block diagram illustrating
5 a distributed data processing system according to the
present invention. As shown in **Figure 1**, the distributed
data processing system includes a metaserver **110**, a
switch **120**, one or more thin servers **130**, network
attached storage (NAS) **140**, network dispatcher **150**,
10 external network **160**, and one or more client devices
170-190. The metaserver **110**, switch **120**, thin servers
130, NAS **140** and network dispatcher **150** are part of a
local area network **100** coupled to the external network
160. In Figure 1, data flow is denoted by lines having
15 arrow heads while actual physical connections are denoted
by solid lines. In actuality, all data packets are
routed through the switch **120**.

The distributed data processing system shown in
Figure 1 is illustrative only. The particular
20 architecture and elements shown in **Figure 1** are not
intended to place any limitations on the architecture and
elements used with the present invention. Rather, the
distributed data processing system may have many other
architectures and may include other elements in addition
25 to, or in replacement of, the elements shown in **Figure 1**
without departing from the spirit and scope of the
present invention.

In the data processing system of **Figure 1**, the thin
servers **130** provide specialized applications to client
30 devices **170-190** via the external network **160** and the
network dispatcher **150**. The thin servers **130** may provide

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any number of different applications, including print applications, database applications, web-serving applications, and the like.

The external network **160** may be any type of data
5 network known to those of ordinary skill in the art. The external network **160** may be, for example, the Internet, an intranet, a wide area network (WAN), local area network (LAN), wireless data network, satellite data network, or the like. The external network **160** may also
10 be any combination of the above.

The client devices **170-190** may be any type of computing device capable of accessing the thin servers **130** via the external network **160** and the network dispatcher **150**. The client devices **170-190** may be, for
15 example, a personal computer, laptop computer, personal digital assistant (PDA), data network capable wireless communication device, and the like. The client devices **170-190** may access applications provided by the thin servers **130** using, for example, a web browser application
20 or the like.

The network dispatcher **150** performs workload balancing with regard to the thin servers **130** with the goal being to avoid looking at every packet, especially every packet sent back by the thin servers **130**. The
25 network dispatcher **150** dispatches jobs or transaction requests to the thin servers **130** and the NAS **140**. The network dispatcher **150** essentially provides a mechanism through which job or transaction requests may be sent to applications running on the thin servers **130**. The
30 responses to these job or transaction requests are supplied directly by the thin servers **130** through the

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switch **120** to the external network **160** and hence to the clients **170 - 190**.

The NAS **140** is a specialized file server that connects to the network. The NAS **140** uses traditional
5 local area network (LAN) protocols, such as Ethernet and TCP/IP and processes only file I/O requests such as Network File System (NFS) (UNIX) and Server Message Block (SMB) (DOS/Windows).

The switch **120** is an electronic device that directs
10 the flow of data from one side of the switch to the other. The switch **120** may be any type of data switching device known to those of ordinary skill in the art. For example, the switch **120** may be an Ethernet switch, a hub, a router, or the like. The switch **120** serves to route
15 data and message traffic to appropriate devices **110**, **130**, **140** and **150**.

The metaserver **110** performs the function of managing the devices in the local area network, e.g., the switch **120**, the thin servers **130**, the NAS **140** and the network
20 dispatcher **150**. In managing these devices, what is meant is that the metaserver **110** performs management functions including collecting data to maintain statistics of historical interest and to monitor the current state of the devices. The metaserver **110** may be a server, as is
25 generally known in the art, or may be a specialized thin server that is used to perform management functions. In the depicted example, the metaserver **110** is a specialized thin server.

The present invention provides a mechanism by which
30 system management information is partitioned and provided to customers of a server farm. With the present

invention, a thin server manager is utilized to aggregate system management information for a plurality of customers of a server farm. The aggregated system management information is then partitioned into sets, one
5 for each leasehold, and provided to adapters of the leaseholder agents in a form that is susceptible to automated computer processing. An example of such a form is a valid XML document with a well-defined document type definition.

10 The adapters translate the received set into a form useable by the leaseholder agents, which then interact with the customer's management system. Thus, the customer's management system software, which is typically purchased from a vendor and may represent a substantial
15 investment, does not need to be changed.

The management server appliance, or metaserver, shown in **Figure 1** operates based on instructions stored in local memory or storage. These instructions may include, for example, computer program instructions for
20 implementing the thin server manager of the present invention. Alternatively, the thin server manager, as will be described hereafter, may be implemented as a hardware component of the metaserver, as software instructions, or a combination of hardware and software.

25 **Figure 2** is an exemplary block diagram illustrating a thin server manager according to the present invention. As shown in **Figure 2**, the metaserver (or other management server) **210** includes a plurality of leasehold agents **222**, **224**, **226**, a thin server manager **230**, and a plurality of
30 adapters **223**, **225**, **227** coupled to respective agents **222**, **224**, **226** and the thin server manager **230**.

The thin server manager **230** aggregates system

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management information from the application subsystems
242, 244 and 246, operating systems 248, 250 and 252,
network interfaces 254, 256 and 258, and hardware 260,
262 and 264, of the individual servers of the thin server
5 farm 280 for each of a plurality of leaseholds.

The aggregated system management information may
include, for example, the assignment of resources to each
leaseholder, the status of each lease, and how the
resources are being used. For example, the aggregated
10 system management information may include an
identification of the applications run under the lease,
the number of thin servers on which the applications for
each lease were run, the amount of network bandwidth used
by each lease, the level of success of running the
15 applications, and the like. The aggregated system
management information may include other management
information in addition to, or in replacement of, the
management information described above.

In a preferred embodiment, system management
20 information may be obtained from the thin server farm 280
by sending requests from thin server manager 230 to the
systems being managed and receiving the system management
information in response to the systems having received
the requests. The request and response messages passed
25 between the thin server manager 230 and the managed
systems are, in a preferred embodiment, in an extensible
Markup Language (XML) format, although other formats may
be used without departing from the spirit and scope of
the present invention.

30 The thin server manager 230 aggregates this system
management information and then partitions the system
management information into system management information

sets for each of the plurality of leaseholds. In partitioning the system management information, the thin server manager **230** uses the lease information, to identify each of the leaseholds and the corresponding
5 system management information. The lease information may be provided to the thin server manager **230** in a parsable format, such as an extensible markup language (XML) document, or the like.

For example, each leasehold may be represented in
10 the thin server manager **230** by a set of data structures that point to the resources owned by that leasehold, the resources (such as NAS, for example) sub-allocated to the leasehold, and information about each of these owned and sub-allocated resources. Based on the information stored
15 in these data structures, correlation of the leasehold with management information from the various managed systems, i.e. resources, may be performed.

The partitioned system management information is then used to generate a document for each of the
20 leaseholds. The document is preferably in a well-defined format that is readily processed by computer programs, such as an XML document, or the like. The documents may be generated at predetermined times, such as daily, weekly, monthly or the like, may be generated based on
25 the occurrence of certain events or the completion of certain activities, or may be generated when instructed to do so by an administrator, or the like. Documents directed to different agents for different leaseholds may be generated at different times, depending on the
30 particular needs of the customer.

The agents **222**, **224**, **226** may include, integrated therein, adapters **223**, **225**, and **227** for the customer

management systems. Alternatively, the adapters **223**, **225** and **227** may be separate devices or virtual entities present in the metaserver **210**. There is at least one adapter **223**, **225** and **227** for each of the leaseholds
5 managed by the thin server manager **230**.

The adapters **223**, **225** and **227** receive the documents generated by the thin server manager **230** and act as a translation layer for the agents of the customer management systems **222**, **224** and **226**. The adapters **223**,
10 **225** and **227** parse the received documents and convert them to the form handled by the corresponding agents **222**, **224**, **226**. For example, the adapter may receive the document in an XML format and convert the document to an application program interface (API) calls, remote program
15 calls (RPCs), or the like.

The converted document is then used by the customer's management system **290**, **292**, **294** to perform system management functions. These system management functions may include sending commands to applications
20 running on the thin server farm. If commands are received from the customer's management system **290**, **292** or **294**, the commands are received by the agents **222**, **224**, **226** and converted into a form usable by the thin server manager **230**, preferably a document in a format such as
25 XML. The thin server manager **230** then determines if the command is an appropriate command, and if so, makes any necessary translations or restrictions and forwards the command to the application. Commands are considered appropriate if they do not interfere with other leases or
30 affect the overall operation of the server farm.

Figure 3 is a flowchart outlining an exemplary

operation of the present invention. As shown in **Figure 3**, the operation starts with receiving system management information from the thin server farm (step **310**). The system management information is partitioned (step **320**) and a document is generated for each of the leaseholds (step **330**). The documents are then transmitted to a customer's management system adapter (step **340**). The adapter converts the document into a form useable by the customer's management system (step **350**) and transmits the converted form of the document to the agent of the customer (step **360**). The agent then operates normally sending the information to be processed by the customer's management system (step **370**). The operation then returns to step **310** to wait for the next set of information from the server farm.

Thus, the present invention provides a mechanism by which system management information from a thin server farm may be partitioned for use by a plurality of individual customer leaseholders. Each customer may use its own management system to receive the partitioned information and perform necessary management functions. Thus, there is no need to incorporate additional functionality into the customer's management system to accommodate managing applications and systems within a server farm at a service provider's site.

While the present invention has been described in terms of managing applications and systems in a thin server farm, the present invention is equally applicable to management of any "farm" of network appliances and devices. For example, the present invention may be utilized with a farm of regular servers, application servers, or the like. The use of a farm of thin servers

in the description of the preferred embodiments is for illustrative purposes only and is not meant to place any limitations on the present invention.

It is important to note that while the present
5 invention has been described in the context of a fully
functioning data processing system, those of ordinary
skill in the art will appreciate that the processes of
the present invention are capable of being distributed in
the form of a computer readable medium of instructions
10 and a variety of forms and that the present invention
applies equally regardless of the particular type of
signal-bearing media actually used to carry out the
distribution. Examples of computer readable media
include recordable-type media such a floppy disc, a hard
15 disk drive, a RAM, and CD-ROMs and transmission-type
media such as digital and analog communications links.

The description of the present invention has been
presented for purposes of illustration and description,
but is not intended to be exhaustive or limited to the
20 invention in the form disclosed. Many modifications and
variations will be apparent to those of ordinary skill in
the art. The embodiment was chosen and described in
order to best explain the principles of the invention,
the practical application, and to enable others of
25 ordinary skill in the art to understand the invention for
various embodiments with various modifications as are
suited to the particular use contemplated.